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Harnessing the power of prediction

Applying the predictive power of a scientific theory to business operations is one of the areas where scientists can deliver huge commercial value. Using this predictive power for commercial gain can be difficult. Knowing what accuracy will add value, getting the right models and getting them used are the three steps to success.

By Andrew Chadwick and David Dungate

Scientific theories underpin many important business decisions. Think of the petro-chemical engineer using geo-physical science to determine the most effective and safest way of exploiting an oil reservoir, the drug discovery scientist using the results of theoretical chemistry to find those chemical compounds most likely to become drugs, or the space engineer who can simulate the behaviour of a space system before ever commissioning it. Moving from a theory to a usable business tool requires deep understanding of a range of mathematical modelling techniques and their limitations, the ability to analyse where a predictive tool can add value to the business and finally practice in effective user interface design and rich visualisation to guarantee adoption.

Real world systems and predictive tools

Unfortunately few real-world environments are simple enough to permit useful prediction based on solution of equations derived from theory alone. Even gravitational motion has no neat and simple solution when there are more than two bodies involved. Given deep experience of a range of mathematical modelling techniques and a touch of inspiration it is nearly always possible to produce a working predictive tool. One available technique is to develop an approximate but tractable mathematical description. An alternative, if there is enough data, is to build empirical models based on statistical fitting. This can usefully predict the behaviour of new examples from the same population, together with its uncertainties. Yet another approach, often used with physical systems such as well-characterised biological systems but also epidemics in real-world societies, is to simulate their expected overall behaviour by performing many iterative calculations on 'local' interactions, with the aid of a computer. Often we find that we need to use a combination of two or more of these three approaches to produce a valuable predictive tool.

Applying predictive tools to business operations

Given that most predictive models produce imperfect information, the question becomes where and how can they be used to deliver value in a business process? Our recent research on productivity improvement in the pharmaceutical industry (see <http://tinyurl.com/6gthybg>) demonstrates that predictive tools used to make go/no-go decisions affecting whole projects must have a very low rate of false alerts. Less reliable methods, however, say 70% accurate, can still create value when used to augment existing techniques guiding the 'next step' in a process of investigation. A good illustration of this can be seen in screening processes for toxicity. Suppose I have a



low-cost *in silico* method and a more expensive but more accurate *in vitro* method, I could choose to combine them by using the *in silico* prediction to point to the compounds that most warrant early testing *in vitro*. In certain cases depending on the project context (risk, cost of failure and value of success, as well as prediction accuracy) this will be the most value-adding approach. (Try our online demo to explore selection of optimal screening strategies - <http://tinyurl.com/38m4cu4>).

Making it work

A nice example of how widely applicable and powerful prediction can be is illustrated in the work Unilever undertook to explore competition between rival brands. Working with Tessella they developed a retail market simulator underpinned by economic theories of consumer and business behaviour. The model consists of a set of companies each selling a product to a population of consumers. Each consumer agent is modelled individually and with unique tastes and preferences. Consumer purchasing decisions are a function of: the compatibility between their ideal product and those products actually available, product price, product advertising and their need to purchase based on their consumption rate. Unilever marketing strategists use the tool to run multiple simulations. This enables them to develop insight into the likely success of a commercial strategy in the real world.

Assessing the Opportunity

As a first step, review your operations and identify areas of your business process where you need to reduce time, cost, risk and wasted value (from unnecessary project termination). Look for existing predictive tools that can be improved, but also areas where an existing process could be augmented or replaced by a predictive tool. Next, assess the accuracy of the predictive tool required to add value, and the cost, time and capabilities needed to deliver it. **If you need help with this then contact Tessella.**

Swiss Federal Archives

The Swiss Federal Archives (SFA) recognised the need for an all-encompassing end-to-end digital archiving system to secure, preserve, manage and access the SFA's digital records into the future. The solution that the SFA finally chose is based on the tried-and-tested Safety Deposit Box (SDB) system, developed by Tessella in partnership with The National Archives of the UK.

By Ann Keen



Business Situation

The SFA are located in the national capital, Berne. The role of the institution is to advise the federal administration on records management and to appraise, to secure and to provide access to archive-worthy records of the Swiss Parliament, Government and Administration. It would need a bookshelf 60 kilometres long to hold the entire archives, which includes original documents such as the constitution and holds data in various formats such as, paper documents, photos, films, recordings and databases.

As well as storing millions of physical documents, the SFA contains a growing number of electronic records. In fact, by the end of 2008, the digital archive had grown to 12.5 terabytes (TB) in size – the paper equivalent of half-a-million trees or the capacity needed to store over 100,000 feature-length movies.

In order to increase efficiency and performance, the SFA's digital archive is based now on an application that manages the whole process from beginning to end. A key priority was preserving the integrity of the file structure, given that many of the digital files being sent for archiving had been stored in well organised record management systems.

"More and more data is now being kept in records management systems that are well structured. From 2012 on, the whole federal administration will have to change to a records management system that integrates already key prerequisites for digital archiving. We need to preserve that structure too in order to guarantee the traceability and comprehensibility of the affairs," notes Urs Meyer, IT architect of the SFA.

In addition, the SFA had to take into account that the digital archives will be expanding rapidly in future, as more and more government business is conducted electronically. To deal with this and other parameters, the SFA developed a digital management strategy and a policy that includes processes and guidelines.

After the SFA conducted a market study, Tessella stood out as the best candidate and was therefore mandated. Key was Tessella's experience with archives, because of their unique requirements among record-keeping institutions: not only do they need to keep records permanent and safe; each file they hold is unique – unlike books in a library, for example, which generally exist in multiple copies. Tessella has a good reputation as the technology leader in digital archiving, and the SDB is nowadays one of the preferred solutions for the archiving community.

Solution

The SFA's digital archive is powered by Tessella's SDB software, co-developed with The National Archives in the UK and used by The National Archives as the basis of its award-winning digital archive system.

A key feature of SDB is 'Active Preservation' technology. This means that the information contained within a record can be preserved even if the record is migrated to a new technology format.

Security of the archives is a key priority. The server(s) reside in a protected network zone. Access is possible only with ICA protocol (Citrix Terminal Server with encrypted communication). Data is stored three times: on a tape library system (two tape libraries from ADIC, now Quantum, at two separate locations) and a disk-based system (NAS Filer from Netapp).

Customisation

SDB is an evolving technology platform that is capable of being tailored to the needs of each client. In the SFA's case, there was a requirement to modify the system in line with the existing security protocol. The SDB software is designed such that all the files in an archival information package (AIP) – the name given to a group of related files submitted for storage – are held separately and it is the metadata describing those files that links them all together. However, for security reasons, the SFA wanted all of the files within the AIP to be held in one place, such that in the unlikely event of the software becoming corrupted, the SFA would know which files went together.

"For us, it was important that the unit of an AIP survives for safety reasons and Tessella did that modification for us," says Meyer.

The SFA also wanted to add new functionality to the software around identifying file formats during the ingestion process. The Droid software to identify file formats was already part of SDB and this is one of the automated tests that is performed during the file ingest. The SFA refined and extended the number of tests, such as structural integrity tests that would, for example, verify whether metadata matched physical files and vice-versa.

Meyer judged the collaboration with Tessella as positive: "We had intensive contact with the designers of SDB and the developers who implemented our solution, and we benefited a lot from that. Communication paths were short, and Tessella was also very proactive. We dealt with very competent people at every stage of the project."

Summary

The SDB solution implemented by Tessella for the Swiss Federal Archives, and the software specification that accompanied it, are vital elements of its digital archive and supports the SFA in the challenging task of preserving the valuable digital records today and for generations to come.

Unique Deltares and Tessella collaboration helps tackle threat of flooding around the world

Delft-FEWS (Flood Early Warning System) is now used by a growing number of agencies and organisations worldwide to forecast flood risk and underpin strategic decision making.

By Frederik van den Broek

Background

More than half of the global population live in coastal, delta and river areas. These areas are economically favoured because of their rich, fertile soil and close connection with the sea and waterways.

However, rising sea and river levels, freak weather patterns and growing pressure on infrastructure have led to an increased risk of flooding, subsidence and soil and water pollution, especially in these low-lying areas.

Water management authorities and agencies around the world have therefore begun using automated systems and modelling to help them manage and plan for flood risk. Masses of data, both meteorological and hydrological, are being combined and processed to produce real-time information and forecasts that provide the basis for flood warning and strategic decision making.

Solution

A growing number of these authorities use a forecasting solution called Delft-FEWS (Flood Early Warning System), which was originally developed in the framework of a European project and was further developed for the UK Environment Agency by Deltares, the independent Dutch water technology institute, and Tessella. The collaboration brought together Tessella's unique blend of scientific and software expertise with Deltares' extensive knowledge of hydrology and software development. The system went live in 2005 and is now fully operational as the National Flood Forecasting System (NFFS).

Since the development of the system for the Environment Agency, Deltares and Tessella have maintained a close long-term partnership, continuing to support and extend Delft-FEWS through a joint team based in the Netherlands.

This has enabled Delft-FEWS to be made available free of charge for other water authorities around the world to customise and integrate into their own forecasting systems. Countries now using the system include the UK, Netherlands, Switzerland, Germany, Italy, Spain, the US, Singapore and Taiwan.

Forecasting models are complicated and computationally intensive; many different environmental factors need to be taken into account. This is why Delft-FEWS is offered as a modular package allowing authorities to plug-in their own models as well as configure and customise to their specific needs. It also means the global community of water management authorities can benefit from each other's developments.

Another benefit is that the system handles all routine functions such as fail-over, real-time data import, data handling, dispatching of forecasts, data analysis, data visualisation and data archiving, which allows forecasters and hydrologists to spend more time analysing results, highlighting flood risks and refining the models.

An Ongoing Collaboration

Simone van Schijndel of Deltares, who manages the team for the Delft-FEWS projects and developments, explains, "As well as adding new functions requested by authorities around the globe, we also provide installation, training and customisation advice. Tessella plays a vital role in this by augmenting our team. Their knowledge of modelling software, professional development techniques and ICT very much complement our expertise in water technology, hydrology and software development. It is a very good fit."

Tessella's role includes implementing new features, maintaining the core of the application, ensuring the software is database and platform independent, performing installations at client sites worldwide, developing and presenting training courses for system administrators, and advising on and implementing software engineering good practice.

Simone also finds the calibre of the Tessella consultants very high. "Because of their scientific background, the Tessella consultants understand where we are coming from. They also relish helping us solve the really big and complex challenges that come in from our user base. And we can always rely on their extensive ICT knowledge, including database design and management, and installation, configuration and integration support."

The Future

Deltares will continue to make Delft-FEWS freely available for water management authorities around the world with the valued help of Tessella consultants. Simone continues, "The important issue for us is helping water managers accurately forecast flood risk and protect their local communities. We are also looking to expand the system to model and predict other environmental challenges such as large outbreaks of algae bloom. Tessella's expertise plays a very important role in new development, as well as in helping us maintain our reputation as one of the world's leading applied research institutes in water technology and hydrology."



ESA chooses Tessella to engineer savings in space system development

The European Space Agency (ESA) has selected Tessella to lead a consortium, including EADS Astrium and Thales Alenia Space, to develop generic sets of unit simulation models that can be used by attitude, orbit and control system (AOCS) providers throughout the project lifecycle, from study simulators through to real time test benches. It is anticipated that the developed models will be a valuable resource for the AOCS development community, providing validated reusable modules that will deliver significant savings in the AOCS development, verification and validation process.

Alan Gaby, director at Tessella said, "We are delighted that ESA has chosen Tessella for this prestigious project. It demonstrates our ability to deliver value to clients by innovative use of advanced modelling approaches. In addition, our team benefits enormously from the participation of two world leading spacecraft prime contractors, EADS Astrium and Thales Alenia Space."

Tessella teams up to help community retreat and conference centre, The Abbey in Sutton Courtenay

Tessella springs into action once again for their annual community day and this year Tessella employees volunteered to help the The Abbey in Sutton Courtenay, Oxfordshire.

A unique medieval building, The Abbey is set in extensive grounds, tucked away in the small village of Sutton Courtenay not far south of Oxford. Tessella set about clearing and maintaining the kitchen garden, clearing out the outhouses and painting the inside of The Abbey.

Christopher Shortall, consultant at Tessella and organiser of the day said, "It was fantastic to see everyone working so hard and we were lucky to have such



Some of Tessella's Abingdon team at The Abbey, Sutton Courtenay, Oxfordshire

great weather for October."

Shortall added, "Not only was Tessella contributing to the community and the up-keep of this wonderful medieval building, but it also proved to be a perfect team-building day."

Brad Strachan, volunteer co-ordinator at The Abbey, said, "We are thrilled with the work that Tessella did and are very impressed with their organisational skills, with such a professional job done in such a short time."

Leading science labs collaborate on open source software

Tessella is pleased to announce that the Oak Ridge National Laboratory (ORNL) Spallation Neutron Source (SNS) has chosen to use Mantid software developed for the ISIS neutron source at the Rutherford Appleton Laboratory (RAL) by Tessella. Mantid (Manipulation and Analysis for ISIS Data) is an open source project for data reduction and analysis of neutron scattering experiments. ORNL and RAL have reached an agreement on the resources they will each commit to the ongoing development and deployment of Mantid, and both will be using Tessella to provide some of that effort.

Mantid was originally developed by a team of Tessella scientists at the ISIS pulsed neutron and muon source in Oxfordshire. It is an extensible, open

source framework independent of instrument or analysis technique, built to professional standards of software development, and has a proven track record of flexibility, extensibility and maintainability.

Grant Stephen, CEO at Tessella Inc. said, "We are delighted that ORNL has chosen to join the Mantid collaboration with ISIS and Tessella to work with them on the Spallation Neutron Source."

He added, "Tessella's unique and unparalleled blend of scientific and software development expertise, combined with our experience from the original development of Mantid, means that Tessella can provide software engineers who can understand the scientific research requirements at SNS and have a detailed knowledge of the existing Mantid framework required to extend and apply it."

Tessella will be providing a team of software engineers, with physics backgrounds, to work at both ORNL in Tennessee and Tessella's Boston office. Contractual responsibility for direction of the software engineers lies with ORNL's Mark Hagan.

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Tessella – successfully delivering IT and consulting services to world leaders in R&D, science and engineering.

Founded in 1980, Tessella is the international provider of science powered technology and consulting services. World leading organisations choose our unique blend of science, engineering and sector expertise to deliver innovative and cost-effective solutions to complex real-world commercial and technical challenges. Our people are high achievers from leading universities and are passionate about delivering value to clients. We are proud that our work makes the world a better place to live in: developing smarter drug trials; preserving the digital heritage of nations across the globe; minimizing risk in oil and gas exploration; controlling the orbit and attitude of satellites; researching fusion energy.

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